NUI Galway
OÉ Gaillimh

Semester 2 Examinations 2010/ 2011

Exam Code(s)	4IF
Exam(s)	B.Sc. in Information Technology
Module Code(s)	CT420
Module(s)	
Paper No.	1
Repeat Paper	N
External Examiner(s)	Prof. Michael O'Boyle
Internal Examiner(s)	Prof. Gerard Lyons
	Dr. Jim Duggan
	Dr. Hugh Melvin
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Instructions: Answer Q1 and any other 3 questions. All questions carry equal marks.

Duration	3 hours
No. of Pages	5
Discipline	Information Technology

Requirements:

MCQ
Handout
Statistical/ Log Tables
Cambridge Tables
Graph Paper
Log Graph Paper
Other Materials

Release to Library: Yes [X] No [ ]

Q1. (i) TCAS (Traffic Collision Avoidance Systems) are fitted to commercial airplanes to minimise the risk of in-flight collisions caused by Air Traffic Control or pilot error. Essentially TCAS ensures that planes on a collision course will **automatically** communicate with and ultimately avoid each other. Using this example, distinguish between the Sample Time and Response Time of the TCAS system and show how these terms are related. You can assume that max speed of both planes is 600 kilometres per hr which in a worst case scenario means a relative closing speed of 1200 kilometres per hr.

[15]

(ii) Outline briefly how computer system clocks work. Explain also how this can impact on the clock granularity.

(10)

As a hard Real-Time System designer for the military, you are asked to compare and contrast the various options that you have for timing sources on an embedded system that must deliver 1 msec accuracy to UTC. The system will be fitted to vehicles that will be network enabled and will need to work in all terrains. You should consider criteria such as reliability, accuracy, operation and cost.

(15)

Q2. (i) You are asked to develop software to control the process **temperature and pressure** within a chemical plant. Using code examples briefly describe how this can be done with Ada and why Ada is a good choice as a programming language in this environment.

(15)

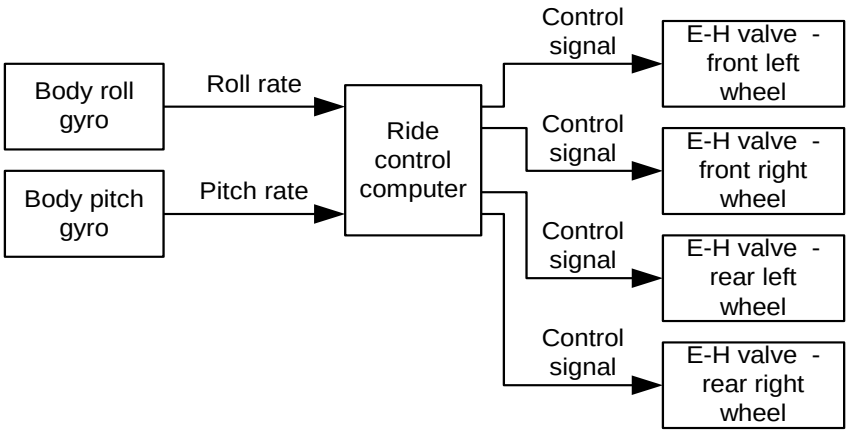
(ii) As a network administrator, you need to ensure that all servers within your Local Area Network are tightly synchronised to within 5 msec. Briefly sketch and describe your design for an NTP subnet to meet this requirement, commenting on all relevant issues (Stratum sources, redundancy, OS platform, network issues etc).

Show using an example how network asymmetry can seriously degrade NTP performance.

(25)

Q3. The diagram below shows the active suspension control system (ASCS) of a formula X racing car. It consists of two rate gyro sensors, a ride control computer and four control valves. These are electro-hydraulic types, one being fitted to each wheel of the car. The purpose of the system is to minimise the pitch and roll of the car (particularly important for high-speed cornering). It does this by:

- Measuring the vehicle's pitch and roll rates.
- Computing the suspension characteristics needed to minimise motion.
- Sending control signals to electro-hydraulic (E-H) control valves to adjust the damping settings of the suspension units.



Vehicle active suspension control system block diagram

i) Distinguish between 4 tasks for the ASCS software (to be executed by the computing module in the centre of the diagram) and assign meaningful (and unique!) periods and execution times to them.

(10)

ii) Using the task structure in i) implement a Cyclic Executive and calculate its time line. Discuss a situation where execution deadlines are not met and provide a solution.

(10)

iii) Enhance your task structure in i) by adding meaningful (and unique!) task priorities. Show how rate-monotonic (RM) scheduling and earliest deadline first (EDF) scheduling will handle the task execution. (20)

Q4. (i) Briefly outline the role of POSIX in Operating System design.

(10)

ii) You are asked to develop a safety critical application that is required to run on a conventional Linux OS that supports many POSIX.4 features. Explain what POSIX.4 features you would use, how you would use them, commenting also on your choice of programming language.

(30)

Q5. The Hubble Space Telescope (HST) is a space telescope that was carried into orbit by a space shuttle in April 1990. Hubble is one of the largest and most versatile optical systems in space. It is well-known as both a vital research tool and a public relations boon for astronomy.
In this question you will discuss various RTS aspects of this system.

(i) Hubble takes high-resolution digital images using its 2.4 m mirror, which are stored locally on a server, before being sent to Earth. Identify environmental challenges for both the primary (e.g. RAM) and secondary (e.g. hard disk) server storage and discuss in detail how information redundancy on both levels can be increased.

(15)

(ii) One of the most important subsystems of the HST is its control momentum gyroscope (CMG) that monitors the position and orientation of the telescope, therefore holding it at a fixed attitude relative to the surface of the earth. The CMG consists of a sensor section (e.g. gyroscope) and a control section (e.g. computer). Discuss 4 (hypothetical) system failure scenarios and outline how appropriate hardware and software fault tolerant techniques / redundancy can be used for their prevention

(15)

(iii) The HST has a radio data link (based on a network of communication satellites) to the Space Telescope Operations Control Center (STOCC) located in Greenbelt, Maryland, where images are archived and further processed. The communication link itself is based on the TCP/IP protocol.
What are the benefits and limitations of TCP/IP in such an environment and what other means of transmission and information redundancy would you suggest to use?

(10)

Q6. (i) In the context of total Mouth-to-Ear (M2E) delay for Voice over IP (VoIP), explain the following terms using an example with realistic values to illustrate your answer.

- Packetisation Delay
- Serialisation Delay
- Jitter Buffering Delay
- Propagation Delay
- Other Software Delays

(20)

(ii) Describe what is meant by lip-synch and what constitutes an acceptable level of lip-synch for a voice/video conference session.

(5)

Outline in detail how the RTP and RTCP SR protocols can be used to implement lip synchronisation for voice/video multimedia streams.

(15)